



Living with Earthquake Hazards in Napa County



Figure 1. Brace that Chimney!

Bracing of masonry chimneys is very difficult to do properly and has generally been ineffective in preventing their failure during earthquakes. While replacement of the chimney with a non-masonry unit is a costly solution, it is also the most effective technique to prevent damage. Always check with the local building department for details and information.

In the early morning hours of September 3, 2000, a magnitude 5.1 earthquake occurred beneath the mountains 10 miles nw of the town of Napa, near Yountville, CA. The earthquake was felt widely throughout the Bay region, and produced significant damage in the town of Napa. This earthquake was a surprise for a number of reasons:

- The earthquake occurred in an area that had been seismically quiet for several decades. The last significant seismic activity was a pair of earthquakes [Magnitude M=5.6 and 5.7] that struck beneath the city of Santa Rosa in 1969. These earthquakes were associated with the Rodgers Creek fault.
- Although seismologists initially thought that the earthquake occurred on the West Napa fault, accurate locations indicated that it occurred about 3 miles west of this fault on a previously unknown fault. Earthquakes of this size can occur anywhere throughout the Bay Area on deep faults that cannot be observed by geologic mapping at the earth's surface.

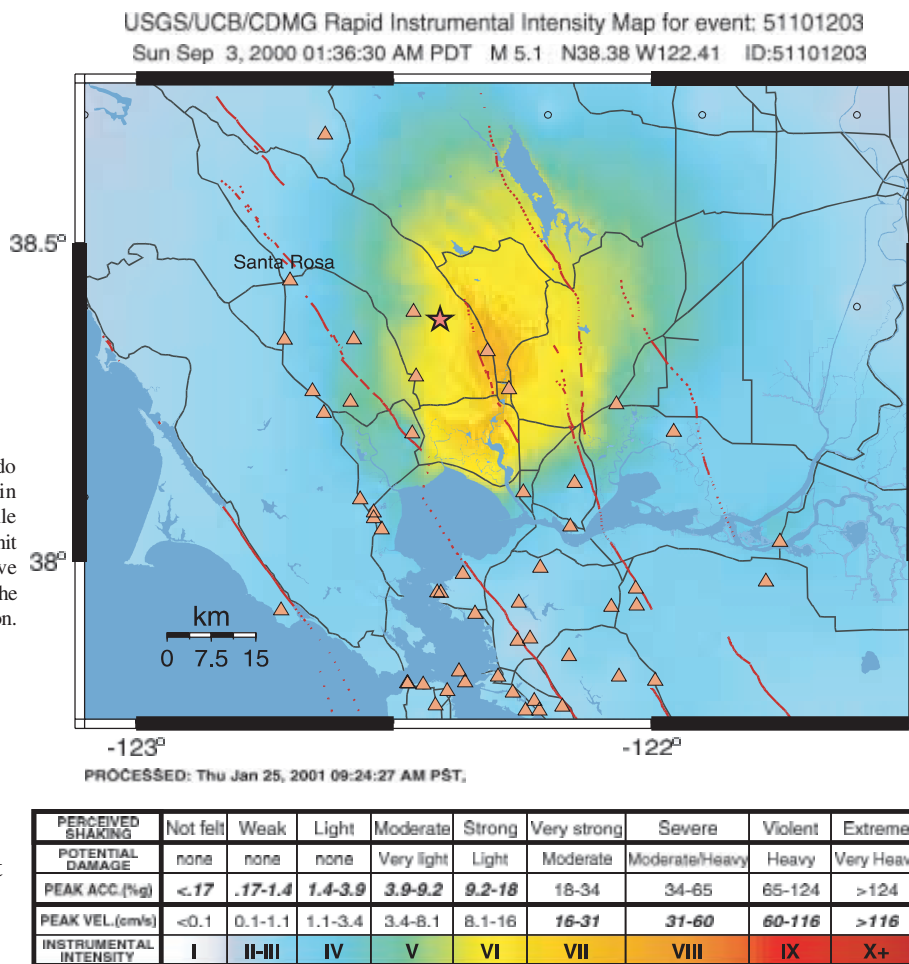


Figure 2: The ShakeMap for the Yountville Earthquake, California, September 3, 2000, shows the intensity of the ground shaking based on actual recorded measurements. Shakemaps are generated quickly for significant California earthquakes and can be found at <http://quake.usgs.gov/recent/shaking.html>.

- The earthquake caused high levels of ground shaking for an earthquake of this size. Recordings of strong shaking by stations operated throughout the region by the USGS, CDMG and UC Berkeley demonstrate that peak shaking levels in the city of Napa were amplified 5 to 8 times relative to a station located in the mountains less than a mile from the earthquake epicenter. While earthquake shaking levels generally die off with distance from the quake, the high levels of ground shaking in Napa appear to have resulted from two factors. First, the shaking was amplified by young, soft sediments along the Napa

River. Second, the earthquake rupture propagated to the southeast from the epicenter, focussing the strong motion toward the town of Napa. Both the high levels of recorded shaking and the local amplification are consistent with the level and concentration of damage throughout the city of Napa.

The Earthquake Threat

The Regional Picture

Since the M 6.9 1989 Loma Prieta earthquake scientists have gained new insights into Bay region earthquakes, providing a better basis for determining quake odds. Earthquake probabilities are based on balancing the continual motions of the plates that make up the Earth's outer shell with the slip on faults that occur primarily during earthquakes. To determine Bay region earthquake probabilities, a USGS working group of nearly 100 scientists from Federal and California State governments, consulting firms, industry, and universities gathered new data, developed analytical tools, and debated a wide variety of interpretations about how future temblors may occur.

This group, known as WG99, determined that there is a 70% chance ($\pm 10\%$) of at least one magnitude 6.7 or greater earthquake striking the San Francisco Bay region between 2000 and 2030. This result is the most important outcome of WG99's work, because any major quake can cause damage throughout the region. This was dramatically demonstrated when the 1989 Loma Prieta earthquake caused severe damage in Oakland and San Francisco, more than 50 miles from the fault rupture. Although earthquakes can inflict damage at a considerable distance, shaking will be very intense near the fault rupture. Therefore, temblors located in urbanized areas of the region have the potential to cause much more damage than the 1989 quake.

Magnitude 6.7 or greater quakes can cause damage throughout the Bay region, but even smaller quakes are serious if centered in an urbanized area. WG99 found an 80% chance of one or more magnitude 6 to 6.6 quakes occurring in the Bay region before 2030. The probability of magnitude 5 earthquakes is even higher.

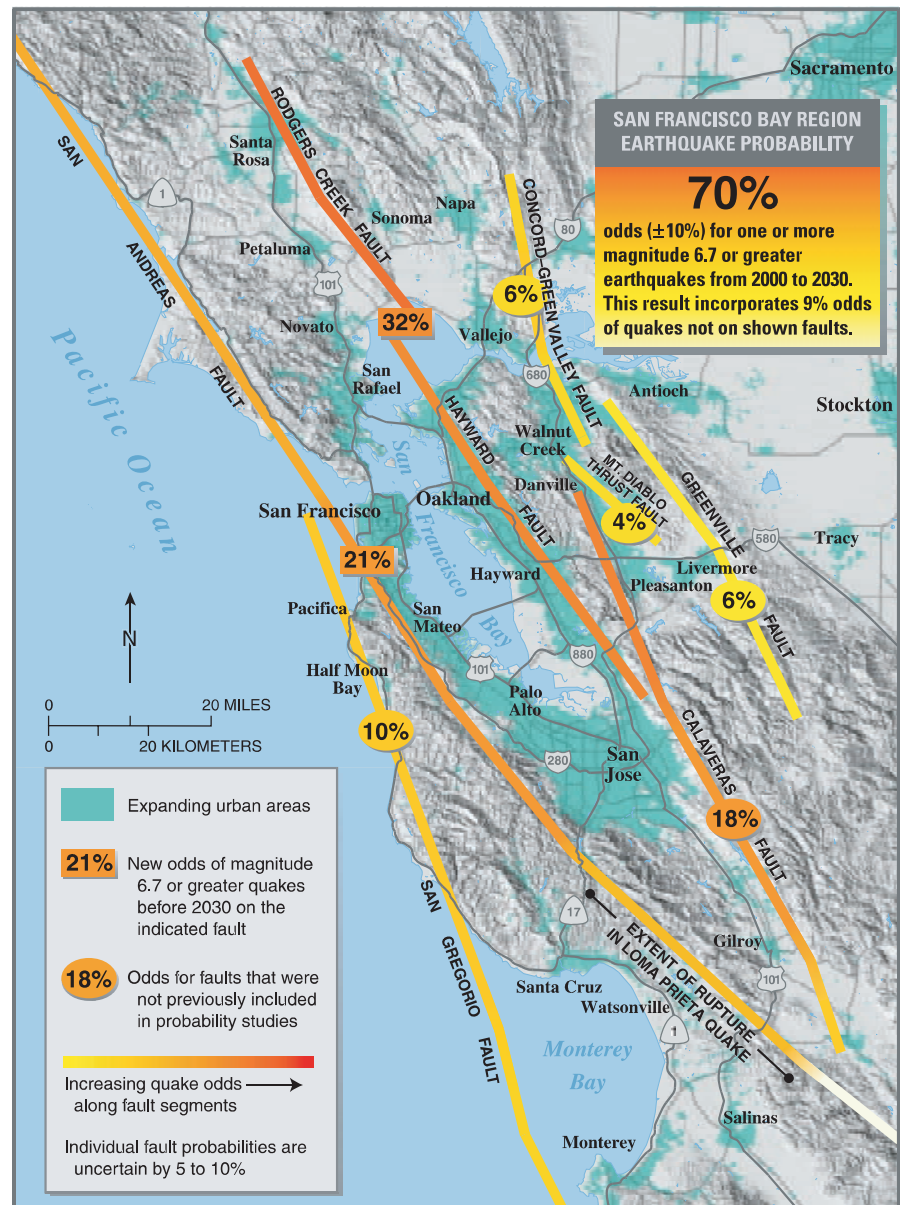


Figure 2. The threat of earthquakes extends across the entire San Francisco Bay region, and major quakes are likely before 2030.

These earthquakes are called "background" events because they may occur off of the main faults, most commonly on small and sometimes even unmapped faults, such as was the case for the September 3, 2000 Yountville earthquake.

The M5.1 Yountville earthquake also showed how even moderate earthquakes can cause significant damage if local geological conditions exist to amplify shaking intensity.

Although quakes cannot be prevented, the damage they do can be greatly

reduced through prudent planning and preparedness. The work of USGS and other scientists in evaluating earthquake probabilities for the San Francisco Bay region is an ongoing part of the National Earthquake Hazard Reduction Program's efforts. These efforts help to safeguard lives and property from the earthquakes that will inevitably strike in northern California and elsewhere in the United States. The WG 99 regional probability results emphasize the urgency for all communities in the Bay region to continue preparing for earthquakes.

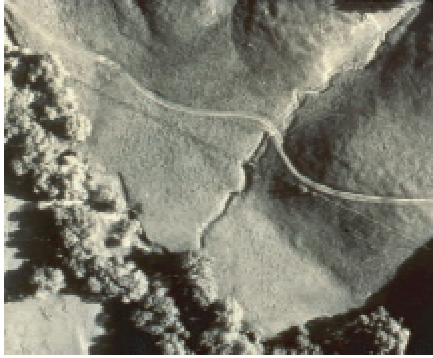


Figure 3. Aerial photograph of the surface trace of the Rodgers Creek fault which runs Northwest to Southeast along the the line of trees.



Figure 4. Tracks of Bay Area Rapid Transit (BART) pass directly over the Concord-Green Valley fault.

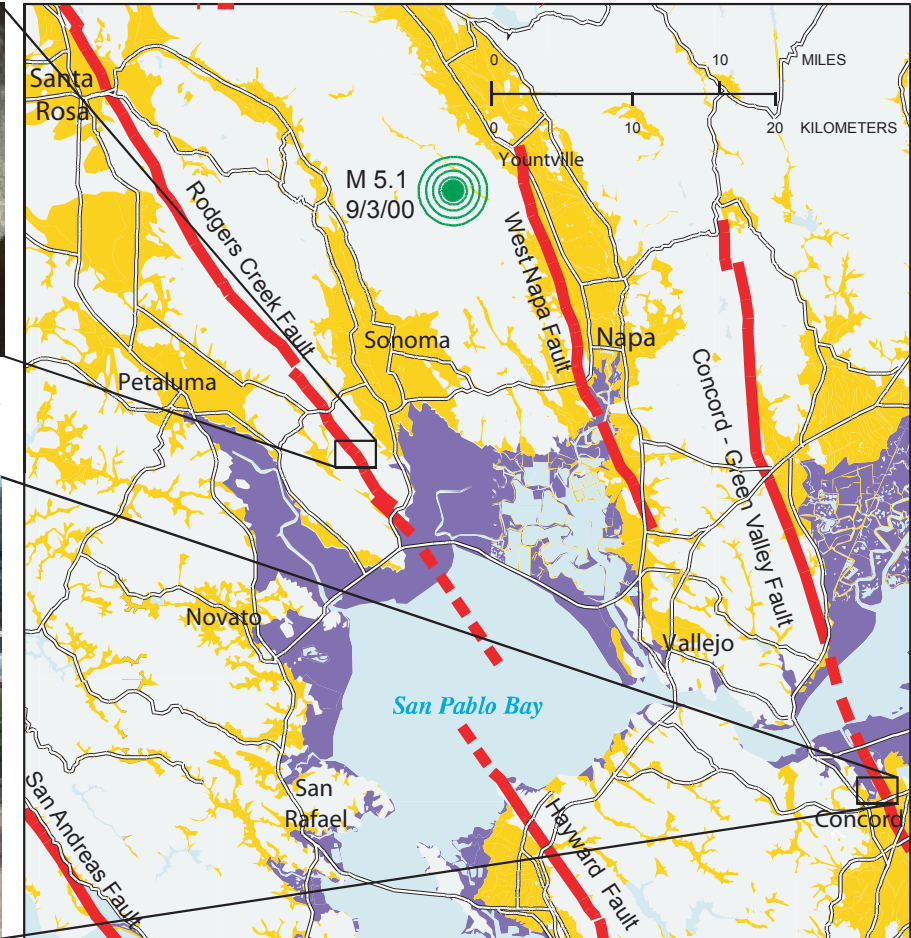


Figure 5. Map showing the epicenter of the September 3, 2000 M 5.1 Napa earthquake in relation to major mapped active strike-slip faults. Areas underlain by unconsolidated bay muds and bay fill deposits are in dark blue; those underlain by unconsolidated Pleistocene and Holocene alluvial deposits are in yellow.

Major Earthquake Faults Affecting Napa County

Napa County is in earthquake country. Three well known Bay Area faults cross Napa, Solano, and Sonoma Counties, and is each capable of producing large earthquakes and strong shaking in the Napa area (See Figure 5).

- The Rodgers Creek fault, located 15 miles west of Napa, is the continuation of the Hayward fault into Sonoma County. It slips at a long term rate of about 9 millimeters/year. The fault is expected to produce earthquakes of M 7 or larger once every 235 years on average. The most recent large earthquake on the Rodgers Creek fault occurred between 1670 and 1776, some 225 to 330 years ago. WG 99 calculated a 30-year probability of 20%, making

the Rodgers Creek the Bay Area fault segment with the highest earthquake probability.

- The Concord-Green Valley fault is 10 miles East of Napa. It is the same fault with two different names. The fault emerges from the north side of Mt. Diablo where the Concord segment passes directly beneath BART, and is visible through downtown Concord because creep has disrupted sidewalks and streets. The Concord-Green Valley fault moves at a rate of about 5 millimeters/year and is estimated to produce earthquakes of M 6.5-6.8 every 800 years. We have no information on the date of the most recent large event on this fault, for which WG 99 has

estimated a 30 year probability of 6%.

- The West Napa fault is closest to the city of Napa but its long-term earthquake behavior is not well known. At present there is no information on earthquake recurrence intervals or when the most recent large earthquake occurred. Its rate of movement is less than 1 millimeter/year. With a rate this low, 30-year earthquake probabilities are generally not meaningful statements of seismic hazard and it was not evaluated by WG99. The West Napa fault is one of a number of Bay area faults that move at a very low rate but will still produce large earthquakes. It is estimated that it can generate earthquakes of M 6.5 to 6.7.

Earthquake Loss Estimation Modeling

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide methodology and software application to develop earthquake losses at a regional scale. These loss estimates can be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risk from earthquakes and to prepare for emergency response and recovery.

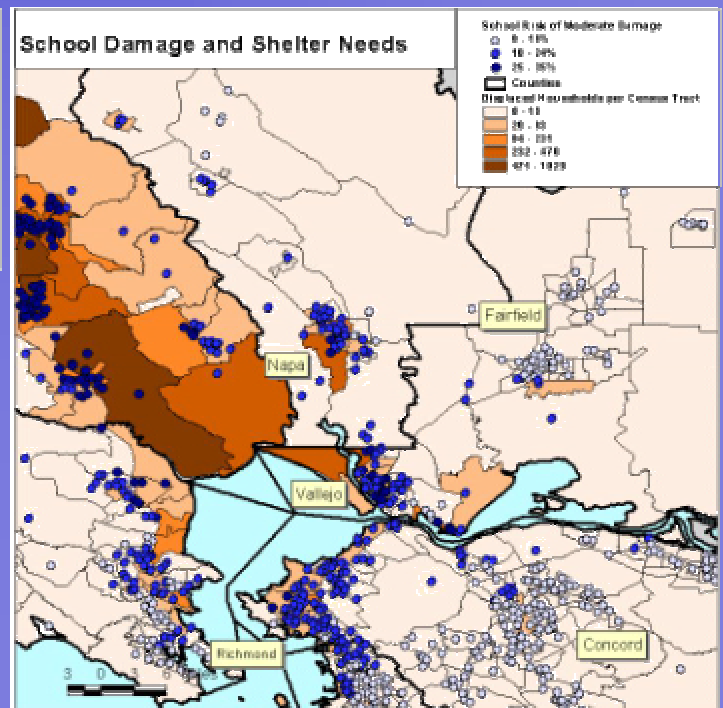
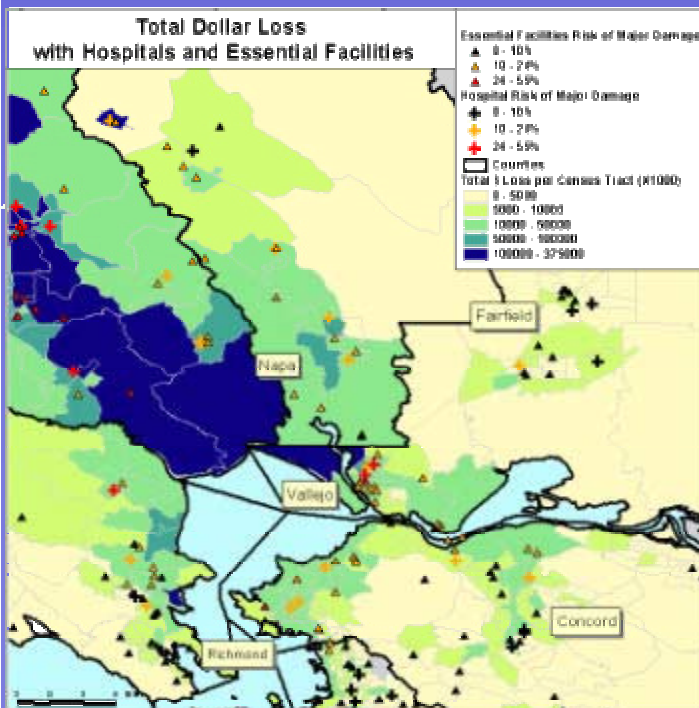
Rodgers Creek Fault - Magnitude 7.1 Earthquake Simulation



Napa County Statistics			
Area (Square Miles)			788
Number of Census Tracts			20
Number of Buildings			
Residential			34,000
Total			36,000
Number of People in the Region			111,000
Building Exposure			
Residential			\$4,800,000,000
Total			\$6,600,000,000
Scenario Results			
Maximum PGA (g)			0.32
Number of Buildings Damaged in Napa County			
Damage Level	Residential	Total	
Slight	8,700	8,900	
Moderate	4,200	4,400	
Extensive	1,300	1,400	
Complete	300	300	
Total	14,500	15,100	
Casualties in Napa County			
Severity 1 (Medical treatment without hospitalization)			440
Severity 2 (Hospitalization but not life threatening)			77
Severity 3 (Hospitalization and life threatening)			10
Severity 4 (Fatalities)			9
Shelter Needs for Napa County			
Displaced Households (#households)			680
Short Term Shelter (#people)			440
Economic Loss for Napa County			
Property Damage (Capital Stock) Losses			\$360,000,000
Business Interruption (Income) Losses			\$160,000,000
Total			\$520,000,000

Bay Area Loss: \$12 Billion

Napa County Loss: \$520 Million



Mitigation Matters!

Mitigation measures are those actions taken to reduce or eliminate the long-term risk to human life and property from natural hazards.



Seismic restraint system for chemical tank, Watsonville hospital



Flood elevation/Seismic bracing to be added, Sonoma



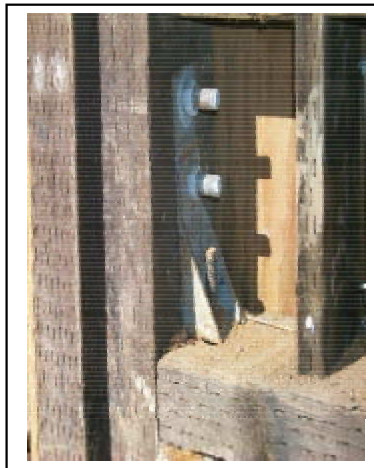
City of San Francisco Fire Department
Station #1 Redesign and Retrofit—essential facility pipe bracing

Earthquake Information and Mitigation Resources on the Internet

<ul style="list-style-type: none">• Earthquake Insurance California Earthquake Authority www.earthquakeauthority.com	<ul style="list-style-type: none">• Napa County Project Impact Information For Flood Partnerships www.fema.gov/impact/cities/im_ca04.htm
<ul style="list-style-type: none">• Earthquake Retrofit Training Seismic Retrofit of wood-frame Structures For Building Contractors & Inspectors www.abag.ca.gov/bayarea/eqmaps/fixit/training.html	<ul style="list-style-type: none">• Earthquake Information California Integrated Seismic Network http://quake.geo.berkeley.edu/cisn Technical Resources: http://quake.usgs.gov
<ul style="list-style-type: none">• Earthquake Preparedness and Mitigation Publications: www.oes.ca.gov & www.fema.gov See Customer Guide in white pages of telephone book	

Mitigation Opportunities

<ul style="list-style-type: none"> • Comply with current seismic building codes and standards 	<ul style="list-style-type: none"> • Initiate strengthening of essential facilities, other critical buildings and known hazards including URM's, unbolted house foundations. Seek financial incentives for property owners.
<ul style="list-style-type: none"> • Initiate local initiatives for residents and businesses 	<ul style="list-style-type: none"> • Expand public/private partnerships to support special mitigation projects and Project Impact
<ul style="list-style-type: none"> • Prepare an inventory of mitigation projects for pre- and post-disaster federal funding programs 	<ul style="list-style-type: none"> • Encourage individual, neighborhood, community preparedness and mitigation activities through community based organizations
<ul style="list-style-type: none"> • Provide ongoing training for building officials and construction professionals in seismic and flood mitigation techniques 	<ul style="list-style-type: none"> • Work with medical groups, schools, city planners, utilities, etc., to support mitigation initiatives
<ul style="list-style-type: none"> • Use FEMA for Kids and USGS The Learning Web websites, Seismic Sleuths, Earthquake Safety Program for Schools, to support programs in the schools 	



Seismic mitigation measures applied to flood elevation structures

For Further Information:

This brochure was prepared for the Napa County Public meeting for city and county officials, February 5, 2001 entitled, *The Future Earthquake Risk to Napa County, California and What to do About it!* Additional information can be obtained from Neal O'Haire, Napa County Office of Emergency Services, (707) 253-4257; Richard Eisner, FAIA, California Governor's Office of Emergency Services, (510) 286-0895; or James Buika, Federal Emergency Management Agency, Region 9, (415) 923-7193.